GEOLOGY PENNSYLVANIA

THE PENNSYLVANIA GEOLOGICAL SURVEY VOL. 10/6

COMMONWEALTH OF PENNSYLVANIA
Richard L. Thornburgh, Governor

DEPARTMENT OF ENVIRONMENTAL RESOURCES
Clifford L. Jones, Secretary

TOPOGRAPHIC AND GEOLOGICAL SURVEY
Arthur A. Socolow, State Geologist

CONTENTS

ON THE COVER: Conneaut Lake in Crawford County; Pennsylvania's largest natural lake; 938 acres. A natural and recreational resource.
Photo courtesy of Bill Bolles, Dept. of Education.

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Editor, Arthur A. Socolow; Associate Editor, Donald M. Hoskins.

DECEMBER 1979

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

COAL IS OUR GOAL

As is appropriate for a geologic agency, much has been written in these columns about the extensive coal resources which Pennsylvania still has available within its boundaries. It may also be appropriate to point out how significant a role coal already plays in our state's economy and energy supplies.

In terms of Pennsylvania's total energy consumption, coal provides 45% of our energy needs, oil provides 34%, natural gas 17%, and nuclear power approximately 5%. Not only is coal the major raw material for our total energy needs, but it is important to note that 75% of our coal needs are provided from within our own state, whereas in the case of oil, natural gas, and nuclear, 88% to 100% of these energy raw materials are brought in from out of state.

Another statistic is worth noting: In the matter of electricity generated within Pennsylvania, coal is the fuel for 77% of our electric generation, nuclear fuel provides approximately 14%, oil 8%, and water power approximately 1% of our electric generation. Again we see the dominant role which our coal already plays in our state's power supplies.

With foreign oil resources more and more unpredictable in price and accessibility, we are indeed fortunate that within Pennsylvania's boundaries we have calculated there is well over 20 billion tons of recoverable coal reserves. At Pennsylvania's current rate of annual coal production of approximately 85 million tons, the recoverable resources can serve our needs for over 200 years. If we can overcome some of the economic, technical, and environmental obstacles to increased coal consumption, we could double our production and still have 100 years of coal reserves in our own "back yard." It is a goal worthy of our maximum efforts. The Bureau of Topographic and Geologic Survey is doing its utmost to provide data answers to the geological problems which remain to be resolved in order to stimulate both coal consumption and production.

Arthur A. Socolow

PENNSYLVANIA SHALE–CHIP RUBBLE

by W. D. Sevon and T. M. Berg

INTRODUCTION

Shale-chip rubble is a useful, but generally unfamiliar construction resource in Pennsylvania. Deposits of this material comprise accumulations of shale and siltstone chips and fragments that range from very small pebble size to cobble size. These deposits can be mapped with a minimum of field data using techniques of aerial photograph interpretation, and they are more widespread than geologists previously realized.

Shale-chip rubble deposits resulted from the downslope accumulation of fragments formed by natural disintegration of several different shale units in Pennsylvania (Fig. 1). These bedrock units principally include the Martinsburg Formation and the Hamburg sequence of the Great Valley, and the Antes, Reedsville, Marcellus, and Mahantango Formations of the Ridge and Valley. These shales are highly susceptible to natural disintegration because of numerous bedding and fracture partings (Fig. 2). The intersections of these surfaces are closely spaced and yield small fragments that are platy, chippy, and hackly. These fragments accumulated a long time ago on low to steep slopes, but mostly at the bases of the slopes. Vegetated slopes underlain by shale-chip rubble are very similar in form to shale bedrock slopes, and the deposits may easily be overlooked. However, careful inspection of tonal differences on aerial photographs can reveal their presence.

DESCRIPTION

The shale fragments are generally platy or chippy, but sometimes are pencil-like or very irregular (hackly). Fragments commonly range in size from 1/4 to 24 inches long, and up to 1 inch thick, but larger pieces occur. The deposits are crudely to moderately well-stratified (Fig. 1, bottom), and stratification is normally parallel to the slope surface. Stratification is the result of variations in fragment size, shape sorting, and clay matrix concentration. The fragments are arranged in either a coarsening-upward sequence or an alternating interbedding of coarse and fine fragments resulting from distinct size

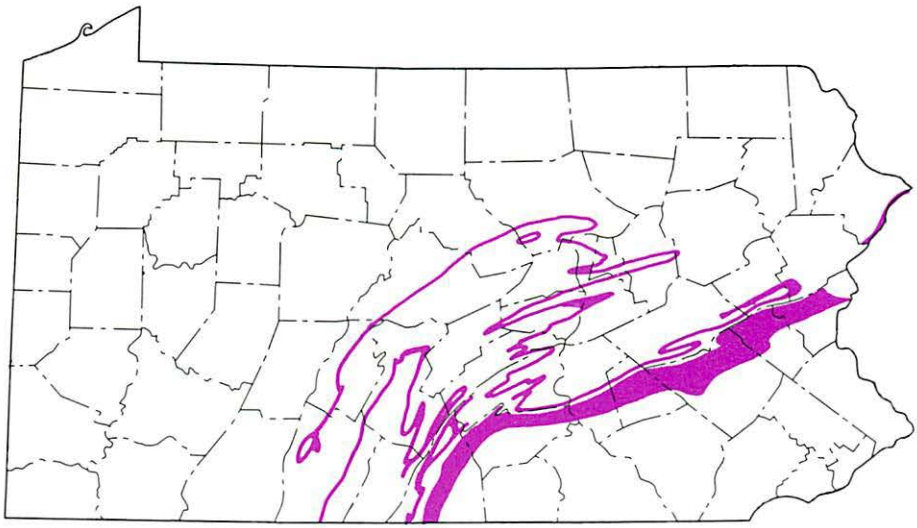

Figure 1. Areas of shale in Pennsylvania where shale-chip rubble is most likely to occur.

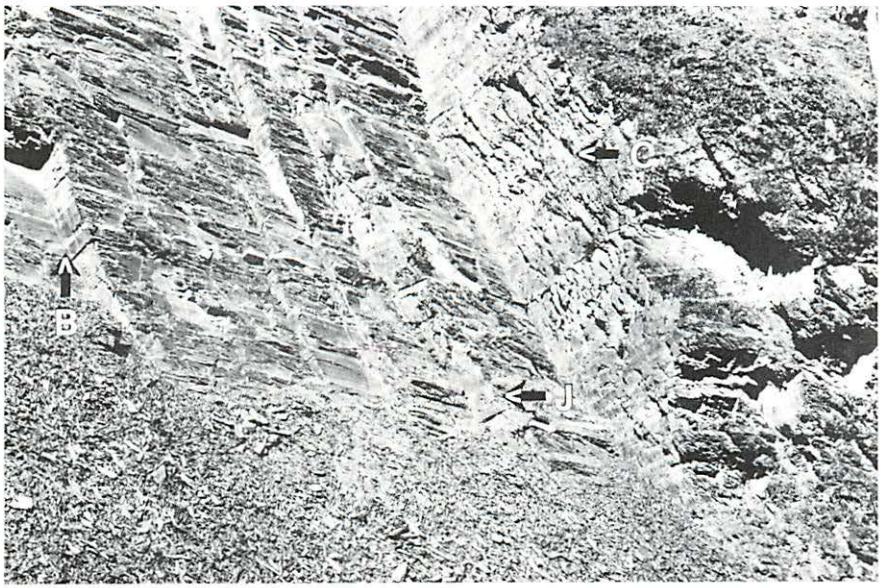

Figure 2. Surface of shale-chip rubble deposit below free face of Antes shale. Note abundance of joint (J), cleavage (C), and bedding (B) planes along which mechanical disintegration occurs.

sorting. The flat surfaces of platy fragments are subparallel to the slope surface, and are frequently imbricated. Long axes of elongate fragments are usually oriented downslope (Fig. 2, lower part).

The shale chips are subrounded to subangular. Although individual chips have a thin clay coating, the deposits have an open framework, are loosely coherent, and are generally well-drained. In color, the deposits vary from dark gray to moderate yellowish brown and yellowish gray.

Fragments in the upper 3 to 6 feet of some deposits are not parallel to the surface, but are oriented in a variety of whorls or prisms (Fig. 3). The fragments are generally chaotically oriented in the center of these structures, and oriented parallel to the structure curvature at its margin.

The deposits occur on the slopes of valleys, sometimes cover the valley floor, and are areally linear. The deposits are wedge-shaped in cross section with the thin edge on the slope at the upper end of the deposit, and the thickest accumulation approximately parallel with the valley floor. Maximum thickness of an individual deposit depends upon valley relief at time of origin and ranges from about 3 feet to more than 60 feet.

ECONOMIC SIGNIFICANCE

Shale-chip rubble has long been mined in many pits (Fig. 4), and commonly used as a fill material. It is sometimes called "chipstone" or "sharpstone," and has been referred to as shale-chip colluvium in some Pennsylvania Survey reports. We have observed its successful utilization as surfacing for low-use roads. The rubble has also been used quite effectively as an impervious backfill material when compacted around structures that may be within the reach of seasonal high water table. Tests run on this material by the Pennsylvania Department of Transportation indicate that it is suitable for shale embankments that can be compacted, in loose 8-inch layers, with normal heavy equipment conforming to their specifications.

Tests of a sample of shale-chip rubble from Monroe County in northeastern Pennsylvania yielded the following results: bulk specific gravity—2.61; absorption—4.22 percent; Modified Washington Degradation Factor—13.3; moisture-density relationship under compaction—maximum density of 122 lb/ft^3 with optimum moisture content of 13 percent.

Shale-chip rubble is easily mined using a front-end loader. The main problems associated with mining are: (1) failure of slopes oversteepened by mining, and (2) downslope movement of trees and other vegetation as a result of slope failure (Fig. 4).

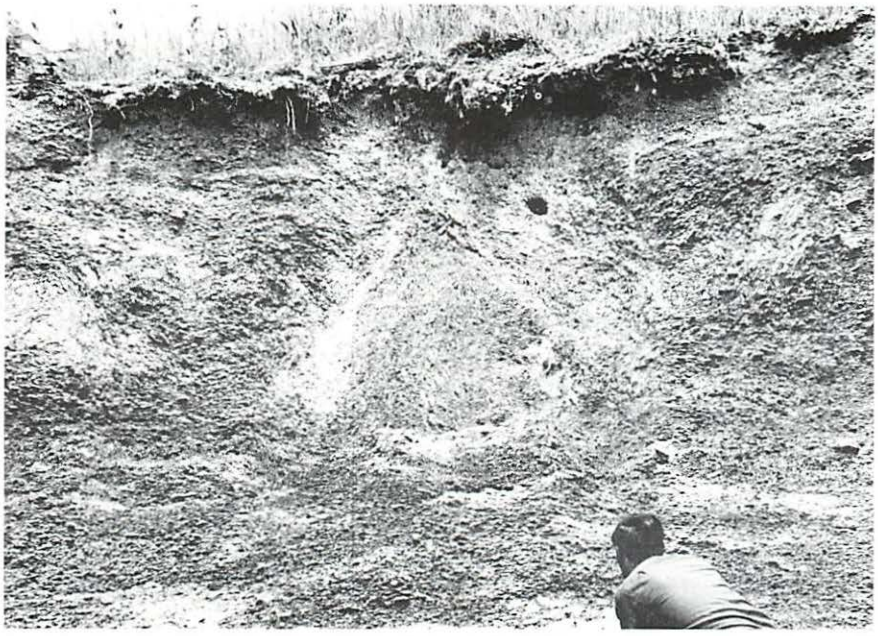

Figure 3. Inverted wedge developed by freeze-thaw distortion of shale-chip rubble formed from Martinsburg shale. Exposure is south of Jacksonville, Lehigh County.

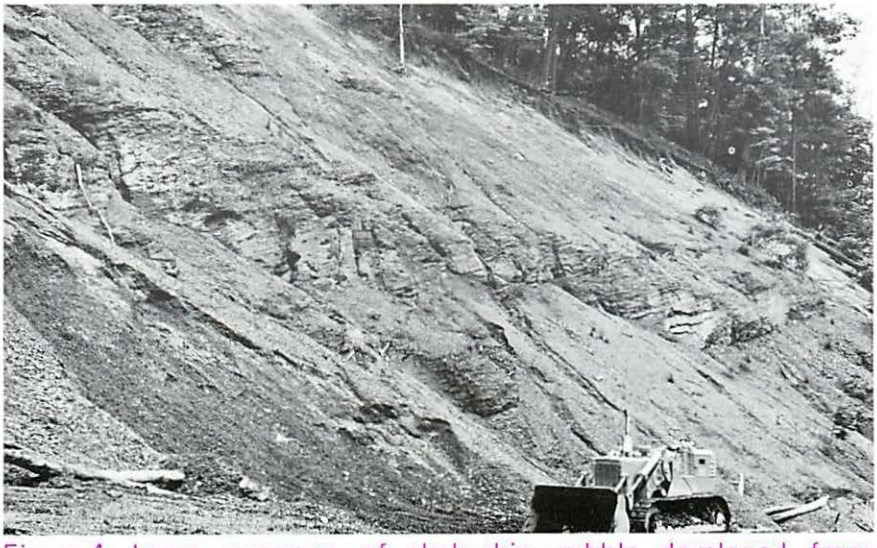

Figure 4. Large exposure of shale-chip rubble developed from Mahantango shale near Bushkill, Pike County.

ORIGIN

The origin of shale-chip rubble (grèzes litées of Europe) is generally associated with periglacial (near a glacier or in arctic regions) climatic conditions, but the exact process of deposition is not known. The processes of sheet flow (overland flow), mudflow, and solifluction are considered the most probable modes of deposition, but rockfall cannot be excluded.

The primary requirement for formation of shale-chip rubble is a sloping, vegetation-free exposure of suitable rock. The high, cliff-like exposures of Mahantango shale along the Delaware River south of Matamoras in northeastern Pennsylvania (Fig. 4) were steepened during the Late Wisconsinan glaciation (the last "ice age"). Thick deposits of rubble occur at the bases of these exposures, and glaciofluvial deposits sometimes interfinger with the rubble. Shale-chip rubble also accumulated in non-glaciated parts of Pennsylvania when ice age climatic extremes were present. During that time much of Pennsylvania was a grassy tundra, and mass-movement conditions common in periglacial climates could have stripped many slopes of all vegetation-supporting soil.

Exposed shale with numerous fractures (Fig. 2) is susceptible to disintegration even under present climatic conditions (debris at base of rock exposure in Figure 2 is modern accumulation), but increased freeze-thaw activity of periglacial climates would result in an increased rate of frost fracturing (congelifraction) of the shale, and increased production of shale fragments (congelifracts). Exactly how these fragments were transported and deposited is somewhat problematical.

Fragments derived from modern rock exposures proceed via rockfall to an accumulation at the base of the exposure or to intermediate accumulations created by irregularities in the rock exposure (Fig. 4). These fragment accumulations (called congelifractates when congelifraction is the primary mode of fragment production) are subject to further movement by sheet flow or mudflow, and the net result of this movement is to lower the slope angle of the deposit. Ancient shale-chip rubble deposits may have initially formed in the same manner.

Those shale-chip deposits which have whorls or prisms (Fig. 3) in their upper part have probably been subjected to permafrost (permantly frozen ground) conditions, and slow, flowage movement (solifluction) after their initial deposition. Such movement and distortion (congeliturbation) of initial uniform bedding occurs when

very deeply frozen ground thaws near the surface and the thawed, water-saturated debris (congelifractate) moves slowly downslope. Some distortion of bedding, such as that shown in Figure 3, may result from expansion and contraction of ice without benefit of downslope movement.

The shale-chip rubble deposits of Pennsylvania were formed mainly during the Pleistocene. Those deposits along the Delaware River in northeastern Pennsylvania post-date Late Wisconsinan glaciation (deglaciation about 15,000 years ago), but precede established vegetation. Some deposits in Monroe County in northeastern Pennsylvania post-date Illinoian deglaciation (over 125,000 years ago), pre-date the subsequent Sangamon Interglacial, and show evidence of Sangamon weathering. Other rubble deposits in the area include Sangamon-weathered glacial deposits within their mass and thus were presumably formed during Wisconsinan glaciation. In one exposure in Carbon County in northeastern Pennsylvania a coarse-grained shale-chip rubble capped with a well-developed soil is overlain, above a sharp contact, by a fine-grained rubble. This sequence suggests two periods of development.

We must thus conclude that shale-chip rubble deposits in Pennsylvania formed at various times during the Pleistocene when climatic conditions favored accelerated frost fracturing and subsequent downslope movement and accumulation. Similar processes, except for solifluction, continue today, but not at such a rapid rate.

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TWO GEOLOGISTS JOIN SURVEY

WILLIAM B. BARBER

Bill joined the staff of the Bureau's Environmental Geology Division on November 8, 1979 as the environmental geologist assigned to western Pennsylvania. His office will be in Pittsburgh and his duties will include assisting individuals and planning agencies on matters dealing with geologic hazards, landslides and general information on the geologic environment.

In 1977 Bill graduated cum laude with a B.S. in geology from Kent State University. Immediately following, he started graduate studies at Kent. His course background dealt with environmental geology, engineering geology and hydrogeology. He was also involved in a variety of consulting work. This work included site evaluation for a prospective sand and gravel operation, housing developments, and detailed topographic mapping of drainage courses. His thesis "A geologic and geophysical survey of glacial drift in Streetsboro, Ohio" involved the use of seismic and electrical resistivity surveys, along with well data, to define bedrock topography and the nature of the glacial drift with respect to possible aquifers and sand and gravel deposits.

Upon acceptance of the Survey position, Bill moved his family to McMurray, PA in Washington County, from Ravenna, Ohio where he was born. Bill lives with his wife Mary Beth and son Justin.

Bill is a member of the National Water Well Association and the Pittsburgh Geological Society.

JAMES R. SHAULIS

James R. Shaulis, a native of Somerset County recently joined the Geologic Mapping Division of the Survey as a coal geologist. His responsibilities include areal appraisals of the bituminous coal resources and geologic mapping in western Pennsylvania. Jim received his B.S. degree in the geological sciences from the Pennsylvania State University in 1971. He has also done graduate work in paleontology and education at Penn State and has obtained teachers certification in earth science and biology from Skidmore College in 1976. Before coming to the Pennsylvania Survey Jim spent over two years working for Skelly and Loy Engineers in Harrisburg, as an exploration coal geologist primarily concerned with the design and supervision of coal reserve evaluation studies in both the bituminous and anthracite fields. In addition to this he also worked for over two years as a director/curator of the Pember Museum of Natural History in Granville, New York. His professional interests include the geology of southwestern Pennsylvania (especially the structure and stratigraphy of Chestnut Ridge anticline). At present as a side project, he is coauthoring, with Dr. Roger J. Cuffey of the Pennsylvania State University, an article entitled "Pennsylvanian Age jellyfish species *Wallcoti cairnbrooki*, the first jellyfish fossils found in Pennsylvania."

NATURAL GAS POLICY ACT (NGPA) PROJECT STARTS

The Bureau's Division of Oil and Gas Regulation started mailing information and forms relative to the Natural Gas Policy Act of 1978 (NGPA) on November 15, 1979. This Act was part of a total National Energy Plan signed into law by President Carter on November 9, 1978 with the effective date of December 1, 1978. The Federal Energy Regulatory Commission (FERC) was empowered to administer the Act by adopting rules and regulations consistent with the provisions of the Act. The Act provides a gradual move toward price deregulation by 1985 of newly discovered gas, with specified price increases for all categories of natural gas determined by well classification. It was necessary to obtain Pennsylvania legislative authority for a state agency to make well classifications as required by FERC. This authority was granted to the Department of Environmental Resources by Act 21, signed into law by Governor Thornburgh on June 28, 1979. Implementing the Act was assigned to the Bureau of Topographic and Geologic Survey's Division of Oil and Gas Regulation.

NGPA Staff—
Standing (left to right): C. Updegraff, R. Walther, F. Sturm.
Seated (left to right): B. Snowdon, B. Bell

The Bureau then prepared regulations based on the federal Act, detailing the procedures that Pennsylvania producers must follow to qualify for well classifications. These regulations were passed by the Environmental Quality Board on October 23, 1979, effective upon publication in the Pennsylvania Bulletin on November 3, 1979.

In the meantime, forms were being prepared and staff recruited to operate the program. Heading up the NGPA project is Charles Updegraff, who has been promoted from his former position of petroleum engineer to geologist supervisor. Joining Updegraff is geologist Richard Walther, who for many years has been an inspector with the Oil and Gas Regulation Division. Newly hired employes are geologist Frederic Sturm, who formerly worked for PennDOT and was a petroleum geologist in Montana, North Dakota and Oklahoma; and clerk typists Barbara Snowdon and Barbara Bell.

The function of the staff will be to process the applications by examining the data submitted by each applicant to justify the category for which he seeks a determination. The staff will be involved in reviewing classification requests for four major categories, "New Natural Gas," "New Onshore Production Well," "High Cost Gas," and "Stripper Well," three of which have several sub-categories. Each category has a different allowable maximum ceiling price set by federal law. It is the staff's obligation to assure that the data submitted with each application is sufficient to meet the federal criteria for the well classification that is requested by the applicant.

A backlog of approximately 4000 applications is on file with many more applications anticipated. A $30.00 filing fee to cover the state cost of administering the program, is required for each well determination application. In addition, a FERC form and Pennsylvania forms must be completed and submitted with geologic, engineering and production data to support the requested classification.

Additional information may be obtained by contacting Charles Updegraff at 412/565-5075 at the Bureau offices in Pittsburgh at 1205 Kossman Building.

PENNSYLVANIA OIL AND GAS FIELDS PROJECT

The Pennsylvania Geological Survey, Oil and Gas Geology Division, has been funded by the University of Oklahoma in Norman, Oklahoma, to revise, update, and standardize the oil and gas fields of Pennsylvania. The proposed two-year project, sponsored by the Department of Energy, involves three major tasks: (1) designation of

the production reservoirs for each of the nearly 30,000 wells on record; (2) determination of the historical information concerning field and pool names, discovery dates, and boundaries; and (3) encoding this information into the University of Oklahoma's computer system. The project will eventually standardize the names and boundaries of Pennsylvania's fields. The Pennsylvania Geological Survey will complete the task by publishing a new oil and gas fields map that will show not only names and general production information (deep vs. shallow; oil vs. gas), but will also indicate boundaries and producing reservoirs for all fields. The project is scheduled for completion in June, 1981.

THE SURVEY AND PENNSYLVANIA TO MISS NATIONALLY KNOWN GEOLOGISTS

DR. JACOB FREEDMAN

The Pennsylvania Survey and the entire geologic community lost a good friend and outstanding scientist in the death of Dr. Jacob Freedman this past July. Dr. Freedman, past co-operating geologist with the Bureau of Topographic and Geologic Survey, past Chairman and one of the original members of Franklin and Marshall College's Geology Department, was a special friend to his students and colleagues alike. For those who knew "Jake," his smile and enthusiasm, his love of geology, and his concern for his fellow man will always be remembered.

Dr. Freedman's best-known work for the Pennsylvania Geological Survey involved the economic geology of the Mount Holly Springs area in Cumberland County. The high-quality white clays of the area, important to our mineral industry in the past, hold still another promise for the future.

In recent years Dr. Freedman's interests involved trace elements in rocks and their importance to human nutrition and health. He wrote and lectured on this topic extensively. In 1975-76, Dr. Freedman was President of the Society for Environmental Geochemistry and Health.

Dr. Freedman is survived by his widow, Bertha, a son David, and a daughter, Marsha.

HAROLD W. ARNDT

Harold W. Arndt, a long-time friend and associate of the geologic community, died November 8, 1979. Most recently, he had been the curator of the mineral collections at Bryn Mawr College, continuing an interest that had developed over the past 50 years. He collected minerals with just about every well-known mineralogist of his time, including Samuel Gordon, Harry Trudell, William Clay, Morrell Baldwin, and Edgar Wherry. But Harold's pursuits were not just confined to minerals. He was something of a botanist, specializing in ferns and orchids; he shared a curiosity, along with his late wife Clair, in bird study; and above all, he was a conservationist, objecting to unnecessary disturbances or destruction of the natural environment.

Harold Arndt was born in Mauch Chunk (Jim Thorpe) in 1892 and graduated from Phoenixville High School. He attended Lehigh University, studying mining engineering under Dr. Benjamin Miller. His studies were interrupted during World War I and, upon his return to the area, he worked as a design engineer for several major steel companies and was responsible for many bridges throughout the country. In 1958, he retired from Belmont Iron Works in Philadelphia.

Harold Arndt was an active participant in many societies and groups in southeastern Pennsylvania. He served as president and vice president to the Philadelphia Mineral Society in the late 40's and early 50's and as president (1953-1960) and treasurer (1960-1977) of the Delaware County Institute of Science in Media. Aside from capably handling the offices he held, Harold showed sincere concern for all who came for help and became a significant influence to several aspiring geologists and mineralogists. Always with a smile and a twinkle in his eyes, he was willing to give his time and his help. Because of failing health, he was unable to attend the last few annual Pennsylvania Field Conferences, but prior to that, he rarely missed one. We at the Pennsylvania Survey wish to acknowledge the dedicated service that Harold W. Arndt provided to the geologic profession.

SURVEY ANNOUNCEMENTS

REPORT ON PENNSYLVANIA'S OIL AND GAS

The Bureau of Topographic and Geologic Survey has published

"Oil and Gas Developments in Pennsylvania in 1978," the annual summary of production and exploration for oil and gas resources in the Commonwealth. Co-authored by Robert G. Piotrowski and the staff of the Survey's Oil and Gas Geology Division, the report highlights increased exploration activities for the year 1978.

During the year Pennsylvania's oil production rose 6% to 2,819,742 barrels from a total of 27,768 producing wells. Oil reserves at the end of the year declined slightly to 48,156,000 barrels, a sign that production exceeded the rate of discovery of new reserves.

Natural gas production in Pennsylvania in 1978 rose to 97,763 million cubic feet, 6% above the previous year. Most significantly, gas reserves still in the ground increased to 2,093,516 million cubic feet; this is up 11% from the prior year, a tribute to effective exploration.

The total number of new wells completed in the state in 1978 was 1748, a 20% increase over the prior year. Drilling for natural gas showed the greatest increase, with Indiana, Westmoreland, Clearfield, Erie and Jefferson Counties leading in gas development.

Progress Report 192, "Oil and Gas Developments in Pennsylvania in 1978," is available from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125. The price is $1.80 (plus tax for Pennsylvania residents).

GEOLOGY OF THE MONTOURSVILLE-MUNCY AREA

"Geology and Mineral Resources of the Montoursville South and Muncy Quadrangles," by senior staff geologist Dr. Rodger T. Faill has been published by the Pennsylvania Geological Survey. Complete with detailed maps of the bedrock geology and glacial deposits (1:24,000) and a comprehensive text, the report enumerates the complex geology and mineral resources which greatly affect and influence the development of this growth area adjoining Williamsport and straddling the Susquehanna River. The increasing demands for building materials, sites for suburban home and industrial development, and the needs for water resources and waste disposal, all require detailed information on the geology of the area.

This new report will benefit a wide range of users. The sections on economic resources and environmental geology provide cogent information for decisions by local officials, county planners, industries, and transportation designers.

Atlas 144ab, "Geology and Mineral Resources of the Montoursville South and Muncy Quadrangles" is available for $14.10 (plus tax for Pa. residents) from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125.

MONROE COUNTY GEOLOGY AND GROUNDWATER RESOURCES

A detailed report "Geology and Groundwater Resources of Monroe County, Pennsylvania" has been published by the Pennsylvania Geological Survey as Bulletin W 47. Authored by Louis D. Carswell and Orville B. Lloyd, Jr. of the U.S. Geological Survey, the 42-page report with its detailed geologic and hydrologic map, is the product of a cooperative project jointly sponsored by the U.S. Geological Survey and the Pennsylvania Geological Survey.

Monroe County includes much of the area popularly called the Poconos, a fast-growing region which is imposing increasing demands upon the geologic and groundwater resources of the area. The availability and quality of the water resources, particularly the largely underdeveloped subsurface water resources, is a key factor in planning for the future of this area.

Bulletin W 47, "Geology and Groundwater Resources of Monroe County, Pennsylvania," will serve the needs of property owners, planners, local officials, and business people, all of whom have a need to deal knowledgeably with the resources of the area. This report is available for $6.50 (plus tax for Pennsylvania residents) from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125.

GROUNDWATER IN THE DuBOIS AREA

Subsurface water availability and groundwater quality are particularly important to the DuBois area of Jefferson and Clearfield Counties where industrial development, population growth, and mining activities all impose special problems upon the water resources of the region. The Pennsylvania Geological Survey has published Water Resource Report 45, "Groundwater Resources of the DuBois Area, Clearfield and Jefferson Counties, Pennsylvania," by Evan T. Shuster. Two large detailed maps (scale 1:48,000) covering eight 7-1/2' quadrangles show (1) groundwater yields and related features, and (2) depths to the water tables and to the top of the subsurface salt water of the area.

The maps, with accompanying texts, will be of benefit to all water users of the area, and particularly to local officials, planners, and developers who must be able to plan ahead for development in relation to water availability.

Water Resource Report 45, "Groundwater Resources of the DuBois Area, Clearfield and Jefferson Counties, Pennsylvania," is available from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125; the price is $5.50 (plus tax for Pennsylvania residents).

ENVIRONMENTAL GEOLOGY OF THE GREATER YORK AREA

A comprehensive atlas with detailed maps of major geologic factors has been compiled by J. Peter Wilshusen of the Pennsylvania Geological Survey and published as Environmental Geology Report 6, "Environmental Geology of the Greater York Area, York County, Pennsylvania." Covering an area from Thomasville on the west to Red Lion on the east, the plates include a geologic and mineral resources map, a groundwater availability map, and a map identifying the engineering characteristics of the rocks of the region.

This environmental geology atlas is the second major urban area environmental atlas produced by the Pennsylvania Survey (Greater Harrisburg Area was the first) specifically designed to identify and present the environmental geology characteristics of an expanding urban area in a format suited to the varied needs of the community. Local officials, planners, developers, industry, and individual property owners can all benefit from the information presented on the maps and accompanying texts.

"Environmental Geology of the Greater York Area, York County, Pennsylvania," EG 6, is available for $13.00 (plus tax for Pennsylvania residents) from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125.

GRAVEL RESOURCES IN NORTHWESTERN PENNSYLVANIA

Recognizing the declining availability of quality gravel resources in northwestern Pennsylvania, Dr. Jesse L. Craft has carried out field and laboratory studies designed to help locate additional supplies of gravel needed to meet the standards of the consuming industries of the region. The results of Dr. Craft's studies are detailed in the Pennsylvania Geological Survey's new Information Circular 86, "Quality of Ground Resources in Northwestern Pennsylvania." This 55-page report, with accompanying figures and tables, identifies the conditions and locations in the field which are most suitable for locating quality gravel resources in the study region.

The report will be of particular interest to land use planners and all who are concerned with various aspects of the construction industry, including highway engineers and industrial developers.

Information Circular 86 is available for $1.50 (plus tax for Pennsylvania residents) from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125.

GEOLOGY OF CENTRAL BERKS COUNTY

A comprehensive report, "Geology and Mineral Resources of the Temple and Fleetwood Quadrangles, Berks County, Pennsylvania" has been published by the Pennsylvania Geological Survey. Authored by veteran staff geologist David B. MacLachlan, Atlas 187ab includes a detailed geologic map, a tectonic map, and a map showing the environmental geology factors which influence land use of this area adjacent to the city of Reading. The accompanying text elaborates on the extremely complex structures and rock types of the Great Valley and Reading Prong provinces encompassed by the report. Economic mineral resources of the area are identified and evaluated in text and map.

This report is a major contribution to understanding the geologic record of one of the most difficult sections of Pennsylvania's geology. With its broad coverage of geologic interpretation and practical applications, the report will be of interest and use to geologists, as well as all who are concerned with land use planning, resource development, and construction design.

Atlas 187ab, "Geology and Mineral Resources of the Temple and Fleetwood Quadrangles" is available from the State Book Store, P.O. Box 1365, Harrisburg, Pa. 17125. The price is $12.25 (plus tax for Pennsylvania residents).

DEVONIAN SHALE MAPS AND REPORT ARE NOW AVAILABLE

The Oil and Gas Geology Division of the Survey has available for distribution two new publications about the Devonian black shale studies in Pennsylvania. In addition to the eleven maps and cross sections announced in the June, 1979 issue of Pennsylvania Geology, we have a structure map of the Onondaga Group and a report on the Devonian shales and sandstones in Pennsylvania.

The Structure Contour Map on Top of the Middle Devonian Onondaga Group in Western and Northern Pennsylvania was published as Morgantown Energy Technology Center (METC) EGSP Series No. 12 at a scale of 1:250,000. The report, called Black Shale and Sandstone facies of the Devonian "Catskill" Clastic Wedge in the Subsurface of Western Pennsylvania, consists of a 40 page booklet and accompanying thirty-nine 1:1,000,000 scale maps. It was published as EGSP Series No. 13.

Both of these items are available free of charge from the Survey or from METC. Requests should be made to: Pennsylvania Geological Survey, Oil and Gas Geology Division, 1201 Kossman Building, Pittsburgh, PA 15222; or Morgantown Energy Technology Center, U.S. Department of Energy, Eastern Gas Shales Project, P.O. Box 880, Morgantown, WV 26505.

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GROUND-WATER LEVELS
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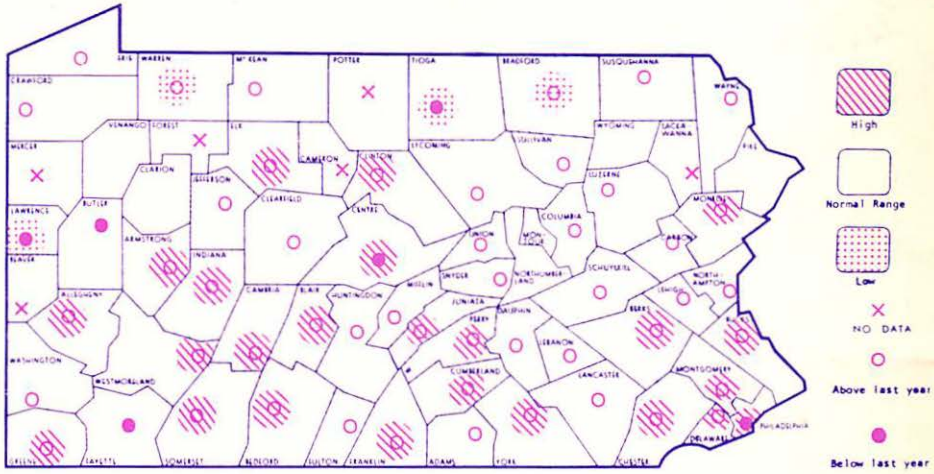

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Address Corrections Requested

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